

RNA Enveloped Viruses

PARAMYXOVIRUSES

-The paramyxovirus family contains four important human pathogens: measles virus, mumps virus, respiratory syncytial virus, and parainfluenza viruses. They differ from orthomyxoviruses in that their genomes are not segmented, they have a larger diameter, and their surface spikes are different.

- Paramyxoviruses are composed of one piece of singlestranded RNA, a helical nucleocapsid, and an outer lipoprotein envelope. The virion contains an RNA-dependent RNA polymerase, which transcribes the negative-polarity genome into mRNA. The genome is therefore not infectious. The envelope is covered with spikes, which contain hemagglutinin, neuraminidase, or a fusion protein that causes cell fusion and, in some cases, hemolysis.

MEASLES VIRUS

Disease: This virus causes measles, a disease characterized by a maculopapular rash. It occurs primarily in childhood.

Important Properties: The genome RNA and nucleocapsid of measles virus are those of a typical paramyxovirus. The virion has two types of envelope spikes, one with hemagglutinating activity and the other with cell-fusing and hemolytic activities. It has a single serotype, and the hemagglutinin is the antigen against which neutralizing antibody is directed. Humans are the natural host.

Transmission: Measles virus is transmitted via respiratory droplets produced by coughing and sneezing both during the prodromal period and for a few days after the rash appears. Measles occurs worldwide, usually in outbreaks every 2 to 3 years, when the number of susceptible children reaches a high level.

Prevention: Prevention rests on immunization with the live, attenuated vaccine (MMR vaccine).

MUMPS VIRUS

Disease: This virus causes mumps, a disease characterized by parotid gland swelling. It occurs primarily in childhood.

Important Properties: The genome RNA and nucleocapsid are those of a typical paramyxovirus. The virion has two types of envelope spikes: one with both hemagglutinin and neuraminidase activities and the other with cell-fusing and hemolytic activities. The virus has a single serotype. Neutralizing antibody is directed against the hemagglutinin. The internal nucleocapsid protein is the S (soluble) antigen detected in the CF test used for diagnosis. Humans are the natural host.

Transmission: Mumps virus is transmitted via respiratory droplets.

Prevention: consists of immunization with the live, attenuated vaccine (MMR vaccine).

CORONAVIRUSES

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Diseases: Coronaviruses are an important cause of the common cold, probably second only to rhinoviruses in frequency. In 2002, a new disease, an atypical pneumonia called severe acute respiratory syndrome (SARS), emerged. In 2012, another severe pneumonia called Middle East respiratory syndrome emerged.

Important Properties: Coronaviruses have a nonsegmented, single-stranded positive- polarity RNA genome. They are enveloped viruses with a helical nucleocapsid. There is no virion polymerase. In the electron microscope, prominent club-shaped spikes in the form of a corona (halo). There are two serotypes called 229E and OC43. The genome sequence of the coronavirus that caused the SARS (CoV-SARS) outbreak is different from that of the existing human strains. The genome sequence of different isolates of CoV-SARS is very similar, so the antigenicity of the virus is likely to be quite stable.

Transmission: Coronaviruses are transmitted by the respiratory aerosol. Infection occurs worldwide and occurs early in life, as evidenced by finding antibody in more than half of children. Outbreaks occur primarily in the winter on a 2- to 3-year cycle.

TOGAVIRUSES

RUBELLA VIRUS

Diseases: This virus causes rubella and congenital rubella syndrome. Congenital rubella syndrome is characterized by congenital malformations.

Important Properties: Rubella virus is a member of the togavirus family. It is composed of one piece of single-stranded RNA, an icosahedral nucleocapsid, and a lipoprotein envelope. However, unlike the paramyxoviruses, such as measles and mumps viruses, it has a positive-strand RNA and therefore has no virion polymerase. Its surface spikes contain hemagglutinin. The virus has a single antigenic type. Antibody against hemagglutinin neutralizes infectivity. Humans are the natural host.

Transmission: The virus is transmitted via respiratory droplets and from mother to fetus transplacentally

Prevention: Prevention involves immunization with the live, attenuated Vaccine.

RHABDOVIRUSES

RABIES VIRUS

Disease: This virus causes rabies, an encephalitis.

Important Properties: Rabies virus is the only medically important member of the rhabdovirus family. It has a single-stranded RNA enclosed within a bullet-shaped capsid surrounded by a lipoprotein envelope. Because the genome RNA has negative polarity, the virion contains an RNA-dependent RNA polymerase. Rabies virus has a single antigenic type. The antigenicity resides in the envelope glycoprotein spikes. Rabies virus has a broad host range: It can infect all mammals, but only certain mammals are important sources of infection for humans.

Transmission: The virus is transmitted by the bite of a rabid animal that manifests aggressive, biting behavior induced by the viral encephalitis. The virus is in the saliva of the rabid animal.

RETROVIRUSES

There are two important human retroviruses: human T-cell lymphotropic virus and human immunodeficiency virus (HIV).

Human Immunodeficiency Virus

Disease: Human immunodeficiency virus (HIV) is the cause of acquired immunodeficiency syndrome (AIDS). Both HIV-1 and HIV-2 cause AIDS, but HIV-1 is found worldwide, whereas HIV-2 is found primarily in West Africa.

Important Properties: HIV is one of the two important human T-cell lymphotropic retroviruses (human T-cell leukemia virus is the other). HIV preferentially infects and kills helper (CD4) T lymphocytes, resulting in the loss of cell-mediated immunity and a high probability that the host will develop opportunistic infections. Other cells (e.g., macrophages and monocytes) that have CD4 proteins on their surfaces can be infected also. HIV belongs to the lentivirus subgroup of retroviruses, which cause “slow” infections with long incubation period. HIV has a bar-shaped (type D) core surrounded by an envelope containing virus-specific glycoproteins (gp120 and gp41). The genome of HIV consists of two identical molecules of single-stranded, positive-polarity RNA and is said to be diploid. The HIV genome is the most complex of the known retroviruses.

Three enzymes are located within the nucleocapsid of the virion: reverse transcriptase, integrase, and protease. Reverse transcriptase is the RNA-dependent DNA polymerase that is the source of the family name retroviruses. This enzyme transcribes the RNA genome into the proviral DNA. Reverse transcriptase is a bifunctional enzyme; it also has ribonuclease H activity. Ribonuclease H degrades RNA when it is in the form of an RNA–DNA hybrid molecule. The degradation of the viral RNA genome is an essential step in the synthesis of the double-stranded proviral DNA. Integrase, another important enzyme within the virion, mediates the integration of the proviral DNA into the host cell DNA. The viral protease cleaves the precursor polyproteins into functional viral polypeptides.

Transmission: Transmission of HIV occurs primarily by sexual contact and by transfer of infected blood. Perinatal transmission from infected mother to neonate also occurs, either across the placenta, at birth, or via breast milk. It is estimated that more than 50% of neonatal infections occur at the time of delivery and that the remainder is split roughly equally between transplacental transmission and transmission via breast feeding. There is no evidence for airborne, waterborne, or insect transmission of HIV.